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16. ABSTRACT

A study was conducted by US EPA Region 3 to determine the dioxin-related impact of the Philadelphia Northwest Incinerator on public health. Specifically, it was designed to assess quantitatively the risks to public health resulting from emissions into the ambient air of dioxins as well as the potential effect of deposition of dioxins on the soil in the vicinity of the incinerator. Volume 1 is an executive summary of the study findings. Volume 2 contains contractor reports, laboratory analysis results and other documentation.

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SUMMARY REPORT

DIOXIN ANALYSIS OF PHILADELPHIA

NORTHWEST INCINERATOR

U.S. Environmental Protection Agency, Region III
Philadelphia, Pennsylvania

January, 1986

SUMMARY REPORT

DIOXIN ANALYSIS OF PHILADELPHIA

NORTHWEST INCINERATOR

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Section I - Introduction

The primary objective of the study conducted by the Environmental Protection Agency (EPA) is to determine the dioxin-related impact of the Philadelphia Northwest Incinerator on public health. More specifically, the study was designed to determine the effect of formation and emissions of a family of compounds known as polychlorinated dibenzo-p-dioxins and polychlorinated dibenzofurans. In this report these substances are referred to collectively by the commonly used term "dioxins". This report summarizes the findings presented in greater detail in other documents and reports which are referenced herein or included as appendices.

A major portion of EPA's efforts was the quantitative assessment of risks to public health as a result of emissions into the ambient air of the aforementioned dioxins (See Table I, page 8). Also considered in the study was the potential effect of deposition of dioxins on the soil in the vicinity of the Northwest Incinerator. In addition, investigations were conducted to determine whether the concentration of the dioxin isomer 2,3,7,8 Tetrachlorinated dibenzo-p-dioxin (TCDD) in the residue ash of the incinerator posed a potential hazard. Of the many variants of dioxins, the isomer 2,3,7,8 TCDD is considered to be the most toxic.

Concern has also been expressed regarding the operation of a sister facility, the East Central Incinerator located adjacent to the Delaware River, across from Camden, New Jersey. Therefore the EPA study included effects of emissions from that facility as well. Additionally, it is to be noted that the analysis of the residue ash at the Northwest Incinerator actually included the ash from the East Central Incinerator. The latter had been transported to the ash pile at the Northwest Incinerator where it was combined with the ash of that facility prior to eventual disposal of all the ash in a permanent landfill.

The procedures used throughout this entire program to sample, measure, and assess effects of dioxins are very complex and represent the most current state-of-the-art technology. Care has been taken to assure the quality of the data obtained and upon which the findings are based. Furthermore, this study has been coordinated with those parties responsible for ongoing broader dioxin studies conducted by EPA; this to ensure that implementation of its activities will have been conducted in a manner consistent with the Agency's national policy.

The following Section II presents the overall conclusions and recommendations. Section III provides background information and discusses the events which led to the decision to carry out the complex and arduous tasks of this study. Section IV presents a summary of the analysis and results obtained. Documents related to this study are listed in the references of Section V; several of these which are considered key are included herein as appendices.

Section II - Conclusions and Recommendations

To establish the health significance of the dioxin emissions from the Philadelphia Northwest Incinerator, EPA has estimated the upper limit of excess lifetime cancer risk attributable to these emissions. Additionally, the Agency has estimated the upper limit of excess annual cancer incidence (i.e., number of added cancer cases per year) in the population of about five million persons exposed to emissions from that facility within a radius of 50 kilometers (approximately 30 miles). On the basis of these analyses, EPA believes that these emissions do not present a significant near-term health concern to people living in the vicinity of the Philadelphia Northwest Incinerator. This conclusion also applies to the East Central Incinerator. However, in view of the estimated (upper-bound) increased lifetime cancer risk of 5 chances in 100,000 in the area of the Northwest Incinerator, and 2 chances in 100,000 in the area of the East Central Incinerator, EPA believes that actions to reduce emissions should be taken as soon as feasible in order to diminish further the low probability of increased long-term health concerns. Furthermore, because the measured emissions of dioxins from the Northwest Incinerator were determined to be significantly higher than what EPA has observed at well designed and properly operated municipal waste combustors elsewhere, and because it has been out of compliance with Philadelphia's emission standards for particulate matter, the Agency believes that these emissions can be reduced further. EPA believes this can be accomplished by implementation of the corrective measures referred to in the following paragraph and detailed in the accompanying Appendix F.

EPA has also concluded from the non-detection of dioxin in the soil and from leachate test results that the soil and water media present no health hazards.

A task group formed to evaluate the operation of the Philadelphia Northwest Incinerator found that a number of improper or inadequate procedures and equipment deficiencies existed at the facility. Specific proposals for remedial action were also provided. A subsequent review by EPA of those proposals confirms the expectation that implementing them, as well as implementing some additional changes, will improve the performance of the Northwest Incinerator and thus reduce emissions. Accordingly, it is recommended that all the reported deficiencies and potential remedies be reviewed by the Northwest Incinerator Task Force with appropriate City officials as soon as possible. Those corrective actions that have not yet been taken, and which are feasible, should be implemented expeditiously at both the Northwest and East Central Incinerators.

Section III - Background

The city-owned Philadelphia Northwest Incinerator has had a history of non-compliance with local regulations. Specifically, public concern was brought on by problems attributable to poor housekeeping, odors, visible emissions, and other nuisances at this facility which processes approximately 20% of the City's trash. Because of these problems, court action against the City of Philadelphia was initiated by a number of community groups. At approximately the same time that the litigants had generally agreed to the terms of a Consent Order designed to rectify conditions at the facility, increased public awareness of incinerator-related dioxins raised new concerns. These concerns were heightened by publicity elsewhere concerning "high" levels of dioxin associated with improper operation of incinerators.*

As a consequence, the EPA was requested to determine the existence of dioxins at the Northwest Incinerator and whether they posed a threat to public health. In August, 1984, EPA conducted a screening of the flyash collected by the facility's electrostatic precipitators. Test results revealed flyash dioxin levels for one of the two incinerator units that were approximately ten times higher than had been previously observed in ash screening tests at another incinerator. The latter facility had been considered to be marginally acceptable for individuals exposed via the air medium.

The above development led to the formation in October 1984 of the Northwest Incinerator Task Force consisting of officials representing the City of Philadelphia, the Commonwealth of Pennsylvania, and EPA Region III. The task force agreed to conduct investigations enumerated as follows and which are discussed in more detail in Section IV of this report:

* The formation of dioxins is generally understood to occur as a result of burning organic material with chlorine-containing materials, both prevalent in municipal waste. Further, this situation is aggravated by improper combustion conditions such as incineration at temperatures too low or incineration with insufficient residence times of the refuse in the furnace.

1) Following shut down and needed repairs of one of two units which demonstrated higher than expected dioxin levels in the ash, comprehensive tests of stack emissions and ash analyses would be conducted at the Northwest Incinerator. The level of dioxin emissions to the atmosphere would help determine any threat to public health. It was subsequently decided to analyze the East Central Incinerator's ash as well; however, stack testing at that facility would not be performed in view of the limited resources available.

2) Tests for dioxin content in the soil would be conducted in the vicinity of the incinerator. Results would establish possible threats to health through contact with the soil.

3) Tests would be conducted to determine the dioxin content in the ash pile which contained co-mingled incinerator bottom ash and flyash from both the Northwest and East Central Incinerators. The level of dioxin would establish any need to require special disposal.

4) An evaluation of the City's incineration facilities was to be undertaken in order to examine operating practices related to emissions of air pollutants including dioxin.

These investigations were implemented during the succeeding several months culminating in March, 1985 with the comprehensive tests of both units of the Northwest Incinerator following refurbishing of the defective unit. As previously noted, limited tests were also performed at that time at the East Central Incinerator. A summary discussion of the analyses performed and the results obtained is presented in the following Section.

Section IV - Summary of Analysis and Results

1. Introduction

The following paragraphs provide a brief summary of each of the analyses conducted to assess the implications on public health of dioxins that are attributable to the operation of the Northwest Incinerator as well as to assess the operation itself. As alluded to previously, a quantitated assessment of the risks to the public because of emissions of dioxin into the ambient air was the major part of this study. Also discussed are those tests to measure dioxin levels in the soil near the incinerator and in the residual ash; qualitative judgments concerning effects of those levels are presented. Each of the succeeding paragraphs identifies and refers to those documents where the various aspects of the study are reported in detail.

2. Air Quality Analysis/Risk Assessment

This portion of the study was designed to determine the maximum lifetime excess risk of developing cancer to the most exposed individual due to concentration of dioxin in the ambient air. The analysis also was designed to determine the upper limit excess annual cancer incidence in the population exposed to incinerator emissions.

The key documents relating to this effort range from: (a) the initial contractor work assignment to perform incinerator field tests to: (b) contractor-reported results and subsequent air quality and risk analyses performed by EPA. These appear in the list of references as items 1 through 12. Table I presents a summary of the calculated results of these analyses which are fully detailed in the following appendices:

Appendix A - Volume I, Technical Report (Reference 9)
Appendix B - Ambient air dioxin concentration predictions (Reference 11)
Appendix C - Risk assessment of dioxin emissions (Reference 12)

It is pertinent to point out that while the emphasis of this entire study has been on the Northwest Incinerator, interest in possible impacts of the East Central Incinerator due to its similarity to the Northwest Incinerator suggested that estimates also be made of its dioxin emissions. However these are open to question since stack emission tests for dioxin were performed only on the Northwest Incinerator units; emissions from the East Central Incinerator were estimated by scaling them to the Northwest Incinerator emissions in proportion to their respective refuse charging rates, as reported by the City of Philadelphia. A summary of the resulting estimated excess cancer risk and incidence that relate to the East Central Incinerator is also presented in Table I. The table lists East Central Incinerator impacts estimated for its operation alone as well as presenting the estimated impact due to the combined operation of the two incinerators inasmuch as their receptor areas overlap. Obviously such a calculation must be understood not to include dioxin emissions from any other conceivable sources of dioxin in the area.

TABLE I - Excess Cancer Risk/Incidence Attributable to Air Emissions of Dioxins*

	Maximum individual lifetime risk to develop cancer	Upper limit of annual excess cancer incidence
Northwest Incinerator (alone)	5×10^{-5} or 5 chances in 100,000	.07 or 1 cancer every 14 years
East Central Incinerator (alone)	2×10^{-5} or 2 chances in 100,000	.06 or 1 cancer every 17 years
Combined Operation of Northwest and East Central Incinerators	5×10^{-5} or 5 chances in 100,000	.12 or 1 cancer every 8 years

* See References 11 and 12 for caveats and assumptions

3. Soil Analysis

The existence of the dioxin isomer 2,3,7,8 TCDD in the incinerator flyash, as determined in the screening test of August, 1984 also raised concern about the levels of dioxin that might be present in the soil in the vicinity of the Northwest Incinerator site. Therefore, in October 1984, a total number of 38 samples were collected in accordance with established procedures from various locations within a 2-kilometer radius of the site. A field report of this effort, containing area maps and the procedures employed, is included herein as Appendix D (also listed as Reference 13).

The samples were sent to contract laboratories for analysis. They reported to EPA that no 2,3,7,8 TCDD was detected in any of the samples (References 14, 15, and 16). On the basis of those findings, it was concluded that deposition of dioxins on ground level surfaces with which persons are likely to come into contact does not represent any measurable health hazard.

4. Ash Pile Analysis

The bottom ash from the incinerators and the flyash collected by the electrostatic precipitators is co-mingled and temporarily stored in a pile on the grounds of the Northwest Incinerator. (The weight fraction of flyash is approximately 3.6% as reported by the City of Philadelphia). The mixing procedure is also followed at the East Central Incinerator whose ash is trucked to Northwest Incinerator ash pile. Periodically, the City of Philadelphia has the stored ash hauled off to a landfill for burial.

When it was determined that the electrostatic precipitator flyash contained levels of dioxin higher than had been previously observed in flyash elsewhere, there arose questions concerning safe disposal of all the ash. Coincident with the collection of soil samples, representative samples were also collected from various locations in the ash pile. Again this effort was in accordance with procedures described in Appendix D. The samples were sent to EPA laboratories for analysis in order to determine whether the contents of the pile constituted a health risk and would require special disposal techniques. As reported in Appendix E (also listed as Reference 17) the levels of 2,3,7,8 TCDD ranged from 26 to 89 parts per trillion.

EPA forwarded these results to the Center for Environmental Health at the Centers for Disease Control (CDC) for an evaluation. The conclusion reached by CDC was that the measured values did not constitute a significant public health threat provided the ash was disposed of in a properly designed and maintained sanitary landfill. An exchange of correspondence (References 18 and 19) which documents the disposal issue is included in Appendix E.

There had also been questions raised concerning the possibility of constituents of the ash pile migrating into surface water. Based on field investigations, which although conducted under generally dry weather conditions, it is EPA's view that migration is not a problem (Reference 20). Further, as is evidenced by the difficulty of extracting dioxins from carbonaceous ash as part of the above-mentioned laboratory analytical procedures, the likelihood of dioxin in the leachate from the ash pile is extremely small. Tests performed for the City of Philadelphia to determine EP (Extractable Procedure) Toxicity in leachate from samples of the ash pile concluded that the residue is not EP toxic (Reference 21 and Appendix E). Although these tests did not test for dioxins per se, the results reinforce EPA's view that the presence of dioxin in the leachate is remote.

5. Operating Procedures

As stated in Section III of this report, the task force formed to investigate issues concerning the Northwest Incinerator agreed to an evaluation of the operating practices at that facility. The evaluation not only consisted of on-site observations but also of reviews of city and plant records and currently available literature on municipal incinerators. As a result of a number of findings, recommendations to improve operation at the Northwest Incinerator have been made. These are included in the November, 1985 Task Force Report on Operating Procedures (Reference 22) which is incorporated herein as Appendix F. The task force report will be the basis for discussion and necessary follow-up action to correct equipment deficiencies and improve operating and maintenance practices.

Since the design of the East Central Incinerator is similar to the Northwest Incinerator, the task force believed that its findings and recommendations concerning the latter facility would, in general, also be applicable to the East Central Incinerator. As a consequence, there was no special investigation conducted at that facility. It is therefore expected that any actions to be implemented by the City of Philadelphia would be applicable to both the Northwest and East Central Incinerators.

Section V - References

1. Work Assignment, EPA Contract 68-02-3891 dated 13 November 1984; Dioxin Analysis of Philadelphia Northwest and East Central Incinerators.

   Attachment A - List of dioxin and furan homologs
   Attachment B - Sampling for the Determination of Chlorinated Organic Compounds in Stack Emissions
   Attachment C - Methods Manual, Sampling and Analysis Procedures for Assessing Organic Emissions from Stationary Combustion Sources Exposure Evaluation Division Studies, EPA-560/5-82-014, January, 1982
   Attachment D - Analytical Procedures to Assay Stack Effluent Samples and Residual Combustion Products for Polychlorinated Dibenzo-p-Dioxins (PCDD) and Polychlorinated Dibenzofurans (PCDF), Prepared by Group C - Environmental Standards Workshop, Sponsored by the American Society of Mechanical Engineers, U.S. Department of Energy, and U.S Environmental Protection Agency, dated September 18, 1984 (draft).

2. Work Assignment, EPA Contract 68-02-3891, Change No. 1, dated 21 February, 1985; Dioxin Analysis of Philadelphia Northwest and East Central Incinerators.

3. Work Assignment, EPA Contract 68-02-3891, Change No. 2, dated 21 August, 1985; Dioxin Re-Analysis of one (1) Philadelphia Northwest Incinerator-sample and review of existing chromatograms from previously conducted sampling.

4. Dioxin Analysis of Philadelphia Northwest and East Central Incinerators, Work Plan, EPA Contract 68-02-3891, Midwest Research Institute (MRI) Project No. 8281-L(1), December 7, 1984.

5. Dioxin Analysis of Philadelphia Northwest and East Central Incinerators: Quality Assurance Program Plan (QAPP), EPA Contract No. 68-02-3891, MRI Project No. 8281-L(1), February 8, 1985.

6. Dioxin Analysis of Philadelphia Northwest and East Central Incinerators: Field Data, EPA Contract No. 68-02-3891, MRI Project No. 8281-L(1), July 8, 1985.

7. Dioxin Analysis of Philadelphia Northwest and East Central Incinerators: Laboratory Results for Particulate and Chlorides, EPA Contract NO. 68-02-3891, MRI Project No. 8281-L(1), July 8, 1985.

8. Dioxin Analysis of Philadelphia Northwest and East Central Incinerators: GC/MS Raw Data, EPA Contract No. 68-02-3891, MRI Project No. 8281-L(1), July 8, 1985.

   Part 1 - Analytical Standards
   Part 2 - MM5 Samples
   Part 3 - Flyash Samples
   Part 4 - Bottom Ash Samples

9. Emissions Test Report: City of Philadelphia Northwest and East Central Municipal Incinerators, EPA Contract No. 68-02-3891, MRI Project No. 8281-L(1), October 31, 1985

Volume I	- Technical Report	
Volume II	- Appendices A -	D, Particulate Calculations, Particulate and Chlorides Laboratory Report - PCDDs/PCDFs, and Quality Assurance Unit Report
Volume III	- Appendices E -	F, Field Data and Modified Method 5 Calibration Data
Volume IV	- Appendix G,	Continuous Emission Monitoring Data
Volume V	- Appendix H,	Chromatograms for Modified Method 5 Samples
Volume VI	- Appendix I,	Chromatograms for ESD Flyash Samples
Volume VII	- Appendix J,	Chromatograms for Bottom Ash Samples
Volume VIII	- Appendix K,	Chromatograms for Sample Reanalysis
Volume IX	- Appendix L,	Second Laboratory Report (Triangle Laboratories, Inc.)
Volume X	- Appendix M,	Chromatograms for Analytical Standards

10. Sample Analysis: City of Philadelphia Northwest and East Central Municipal Incinerators, Appendix 1 - Chromatograms EPA Contract No. 68-02-3891, MRI Project No. 8481-L(1), December 6, 1985.

11. Memorandum from Alan J. Cimorelli to W. Ray Cunningham dated January 10, 1986, Ambient Air Dioxin Concentration Predictions for the Philadelphia Northwest Incinerator.

12. Memorandum from David H. Cleverly to Donald Barnes, Chairperson, Chlorinated Dioxin Work Group and W. Ray Cunningham, Director, Air Management Division, Region III, dated January 10, 1986, Risk Assessment of Emissions of CDD's/CDF's from the Philadelphia Northwest Municipal Incinerator.

13. Report R-585-11-4-11, A Field Trip Report for Northwest Incinerator Dioxin Screening, prepared under EPA Contract No. 68-01-6699 dated February 11, 1985.

14. Memorandum from John Austin to Walter Lee dated November 9, 1984 documenting soil sampling results by California Analytical Laboratories.

15. Memorandum from Central Regional Laboratory staff dated November 29, 1984 documenting soil sampling results by ETC Corporation.

16. Memorandum from Diana J. Pickens to Walter Lee dated February 12, 1985 documenting soil sampling results by ETC Corporation.

17. Memorandum from Robert Kramer to Bruce Smith and Ray Cunningham dated December 27, 1984; EPA Laboratory Analysis Dioxin Concentration - Ash Storage Philadelphia NW Incinerator.

18. Letter from Stanley L. Laskowski (Region III) to Georgi Jones (CDC) dated December 17, 1984 requesting health assessment of ash samples.

19. Memorandum from Vernon D. Houk, MD (Centers for Disease Control) to Charles J. Walters (EPA Region III) dated December 26, 1984; Review of Northwest Incinerator Dioxin Screening Results of Ash Pile Philadelphia, Pennsylvania.

20. Memorandum from Leo J. Clark to Harry Harbold dated September 17, 1984; Trip Report, Northwest Incinerator.

21. Lancaster Laboratories Analysis Report to the City of Philadelphia dated December 14, 1984.

22. Northwest Incinerator Operating Procedures, Task Force Report dated November, 1985.